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Does complexity belong inside the firm, or out?

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ABSTRACT

This theoretical article presents evidence that companies choose to impose complexity on their customers, rather than comprehend system complexity internally. It argues that externalising complexity in this manner is fundamentally different from the externalisation of costs and risks as usually described in the literature, because its impact is on the customer's attention, rather than (just) on the customer's wallet or health. Attention is a limited resource. Thus, exporting complexity should reduce the buyer base, leaving only the buyer segment that will tolerate the drain on their attention. It does not seem to be a tactic that is viable for the long run.

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1. Introduction

A sizeable literature exists on the theory of externalities (e.g., Cornes & Sandler, 1996; Limprayoon & Phillips, 2011), and business sceptics have called out companies' tendencies to deliberately externalise costs and risks while internalising profits (Henderson 2012; Lawton & Lederer, 2016). In a separate stream, Linstone and Phillips (2013) wrote of the need to forestall system complexity, including organisational complexity within the firm. Their article argued that slowing or preventing the growth of complexity, though difficult, is easier than managing complexity once it is established.

Researchers did not foresee what is now happening, namely, that companies would begin to externalise system complexity. This article will give examples of this behaviour, and outline its long-term practical consequences. (They are not pretty.) The article offers examples in which the 'externalising complexity' strategy is already beginning to fail.

In standard externality theory, a polluting factory (for example) harms the health of nearby residents, and imposes on them the dollar costs of health care (if such is available and affordable). In contrast, externalised complexity compels the outsiders' *attention*, and often, their time-consuming action.

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The theory of externalities will need to be extended to cover the exportation of complexity, as its nature is different from the externalisation of costs or risks. Marketing theories and practices based on segmentation and variety-seeking also will need to deal with complexity as an externality.

2. Complexity, externalities, and the firm

In economics, a transaction's externalities are defined as impacts felt by non-participants in the transaction. Here, however, I use the word more generally to denote any activities and effects that the firm externalises, or pushes to the outside of the firm's boundaries. Of particular interest are those effects that are complex. They may affect transaction participants and non-participants alike, but are most likely to affect customers.

The Santa Fé Institute defines complexity as that which 'arises in any system in which many agents interact and adapt to one another and their environments'.¹ The Institute notes that in such systems, 'evolutionary processes and often surprising "emergent" behaviors arise at the macro level'.

Business firms dislike surprises. A lot of literature (e.g., Kamo & Phillips, 1997; Phillips & Su, 2013) has conceptualised the firm as a complex system. Perrow (1986), Huber (1990), and Brown and Eisenhardt (1998) detailed the deleterious and potentially fatal effects of excessive complexity within the firm, and Casti (2012) did the same for extreme complexity in the public sphere. In Perrow's view, *all* organisations feature complex sociological interactions and are therefore complex systems. Stacey (2010) goes even further, arguing that in today's technology economy, managerial planning and continuity must give way to leadership in an (internal and external) environment of unpredictability. Not surprisingly, and contrary to Stacey's advice, when managers can compartmentalise a complex subsystem of the overall organisational system, and make it someone else's problem, they will often do so.

In §3, an example clarifies the idea of complexity within the firm. We then move on to the question of whether complexity generated by the firm belongs inside its walls or out. We find the answer is 'sometimes in, sometimes out', depending on a number of marketing and ethical considerations, some of which call for new advances in theory.

3. Complexity in the firm

We frame the example in terms of options (decision trees; see Trigeorgis 1996). Consider a trio of decisions.

The acquisition of a fleet of buses has one value to the acquiring company if later decisions about maintenance are made in a certain way, e.g., if the oil is changed at certain intervals. It has a different, much lower lifetime value if the oil is changed less frequently or not at all. The net present value (N.P.V.) of the acquisition is calculated on the assumption that qualified mechanics will follow the maintenance manual, replacing oil of the designated quality at the prescribed intervals.

This is not a complex situation. The decision was implicitly a 'real option', with the value of the acquisition depending on future decisions (to change the oil or not to change the oil). The company was simply very sure that the later decisions would be taken correctly. Therefore it did not bother with the detailed real option calculation.

A broker takes an option on a security. The option's value depends on exercising it (or not) at the proper time. The broker directs his desktop computer to alert her when the strike price is reached or the option is about to expire. Again, not complex.

In great contrast, innovative firms stubbornly stick to no-option N.P.V. calculations when evaluating potential projects (Phillips 2001, pp. 177–184). Why? Because they cannot rely on (highly paid, incidentally) executives to make the subsequent decisions that maximise the project's value. Unlike the oil change situation, there is no 'manual' for the non-routine executive decisions that fast-changing international markets demand.

Inter-divisional mistrust, the principal–agent problem and lack of strategic alignment, faulty economic forecasts and spun or fake political news, etc. confound the future of such projects and can raise unanticipated possible decision paths.

Surveyed as to why companies do not use real options (usually considered to be a superior valuation tool relative to N.P.V., when the go-no-go decision is to be followed by other decisions) when choosing projects, technology industry middle managers' top answers (Phillips 2001, pp. 177–184) included:

- Operations executives defend their own projects, offering overly optimistic progress reports.
- Company practices may inhibit expansion or discontinuance following a project's inception – possibly due to the expense of midstream evaluations.
- Employee turnover means information critical to the subsequent decisions may not be conveyed or comprehended.
- Operations executives disagree with the project valuations made by financial officers.

In sum, operational projects are complex. They involve multiple semi-autonomous agents (managers and executives), interacting (in trustful, forthright ways or otherwise), and adapting to one another and to changes in the firm's environment. We add that the 'birth and death' of agents (management hires and departures) add to the complexity, both in theory and in practice.

Companies find this complexity uncomfortable. Financial executives may try to accommodate it by inserting an 'uncertainty correction' into their N.P.V. calculus. We can now see that a probability-based uncertainty correction is a clumsy proxy for 'many agents interacting and adapting to one another and their environments'.

4. Externalising complexity: examples

Companies appear to be exporting complexity to customers and the public. This section offers several current examples. A discussion follows the examples.

4.1. Digital television

The analogue T.V. of my childhood had an ON/OFF switch. Remote control? That was my father commanding, 'Son, turn to Channel 3.'

Now, you cannot simply turn on a T.V.; you must boot it up. Digital T.V.s with cable and Internet connections involve up to three remote controllers, each with a plethora of buttons, plus a variety of H.D.M.I.-connected² devices.

This affords more viewing choices for the home. However, much of the benefit of digital subscription television flows to advertisers, who can now close the sale via the T.V.'s interactive feature – eliminating the expense of processing phone and mail orders.

4.2. Credit cards

Charge cards originally expected payment at the end of the month. They morphed into credit cards, with interest charged for late payment. By 2019, the cards involved tiers of interest rates, plus cash advances, cash-back offers (but only at certain merchant categories, and these change frequently), tie-ins with hotel point programs, and other complications.

These complications are expensive to advertise and administer. Retailers in the U.S.A. have begun to request that customers pay in cash, as merchant credit card fees have grown to be a significant determinant of retailers' ability to stay in business.

Recently vendors have gained the ability to charge a customer's card without the customer's signature. Consumers wishing to carefully reconcile their expenditures against their card statements now face an additional task as each billing period ends.

4.3. Airlines

Sider (2018) reports in the *Wall Street Journal* that Delta Air Lines' new boarding procedures:

... will divide its passengers into as many as eight boarding groups, up from six. Passengers in four of those groups board before the main cabin. ... The changes have made getting passengers aboard even more complex. ... The new approach is putting some frequent fliers on edge.

Forbes echoes the observation: 'If airline boarding processes weren't complex enough, starting on January 23, 2019, Delta Air Lines will be introducing an even more convoluted way to board. ... What Delta is switching to has many confused' (Whitmore 2018). Sider (2018) notes that American Airlines now enforces nine boarding groups.

All observers agree that baroque boarding regimes increase ground time at the gate – time that bean counters elsewhere in the airline company would like to minimise. The operational result has flight attendants haranguing passengers to move along, get out of the aisle, and bin their bags quickly. Isn't blaming the customer for flight delays (or really, for anything) the worst marketing imaginable?

Travellers wanting to book complex itineraries do need the expertise of a travel agent. The airlines, having cut commissions to professional agents, and having imposed fees for booking by telephone, instead send the traveller to book on the airlines' websites. The (complex) sites fall on the spectrum of confusing to non-functioning. The 'aggregators' web pages are at least as bad. The traveller may, of course, take on the task of seeking out one of the much smaller number of remaining travel agents that take their commissions from the traveller.

4.4. Ride apps

Simpler and cheaper than taxis – that’s how they started. Drivers and passengers rating each other seemed to be an excellent safety measure for both parties. Then things got complicated. The simple apps metastasised, asking for post-trip comments (in addition to star ratings), asking for tips for the drivers, asking for comments *during* the trip (Ward 2018), warning of extra charges for waiting and for intermediate stops, and presenting multiple classes of service. Uber has just launched a loyalty points program.

The ratings, it turned out, are nearly useless. Drivers have assaulted passengers. Drivers know that drunken Saturday night passengers are likely to empty their stomachs onto the back seat. Their fares are needed, so the drivers pick them up anyway. This became especially true during the 2018–19 U.S. government shutdown, when many Transportation Security Administration (T.S.A.) officers quit their jobs³ and started driving for Uber and Lyft (Calfas, 2019), boosting competition for fares. Riders consult third-party sources of advice on how to stay safe when using ride apps.

A May 2019 ad on Facebook urges, ‘See what’s new in the Uber app.’ Must I?

4.5. Computer security

Individual personal computer buyers may be expected to know next to nothing about computer security. After purchasing their machine, they must research the offerings of anti-virus, etc., vendors, while remaining alert to phishing, identity theft, and other scams. Both of these tasks are beyond the capability of the average computer user.

Why don’t computer hardware and software vendors guarantee security, as one would think to be the proper course? This is a complexity they do not care to take on. Curiously, some credit cards offer identity theft insurance. But they do not offer identity theft prevention.

4.6. ERP systems

Decades have passed since the average user of desktop business software cracked open the accompanying manual. Vendors have admirably made the software’s interfaces ‘intuitive’ (as the industry term would have it), and simplified the steps users must take to execute various functions.

The exception is enterprise resource planning (ERP, also known as enterprise information systems) software. The leading vendors have failed to simplify. They offer certification courses; naturally, the client must pay for these. Incredibly, the vendors have persuaded universities to offer ERP certification courses for credit, at the universities’ cost and risk.

4.7. Computers and shipping services

A leading personal computer vendor used to allow buyers to place orders online. In a turnabout, it eliminated this capability. Buyers must now interact with a salesperson (by phone or online chat).⁴

A brand-leader in package shipping used to make it simple to send a domestic envelope: Fill out the label, affix it to the envelope, and drop it in the collection box. Now one must stand in line to endure interrogation from a human agent, before the envelope is accepted.

Both companies want the opportunity to upsell. The computer vendor to sell you a more powerful computer with more accessories than you think you want; the shipper to sell you overnight delivery and insurance.

Normally in dealing with a company, one might welcome the chance to interact with a human. But not when it means a compulsory but unnecessary drain on one's time and attention. And a possible parking fine, if the line is long.

5. Why is externalising complexity different from externalising costs and risks?

The answer to this question is twofold. First, traditional negative externalities cause monetary damage to non-participants in a transaction, and in the case of pollutants, health harm to participants and non-participants alike. Complexity as an externality places burdens not (only) on the recipient's wallet or health, but on the recipient's *attention*. And attention is the new scarce resource (Wu & Huberman, 2009; Davenport & Beck, 2001).

When we don't have enough money, we can (often) get more. Not so for attention. The scarcity of attention is absolute. Paying attention to work, home and family already takes up many of each day's waking hours. The companies pushing additional, attention-grabbing complexity at customers must soon 'hit the brick wall' that limits the customers' capacity to pay attention.

Second, complexity induces unexpected interactions and emergent behaviour. When a firm decides not to forestall or reduce complexity internally, but instead to export the complexity to the customer, it reduces the firm's ability to predict customer behaviour. The complexity may change the customer's life (to the customer's and the vendor's great surprise). It may allow customers to find new ways to game the system.⁵ It is likely to cause the customers, who have reached the limit of their attention budgets, to walk away.

The situation is peripherally related to research on information overload and variety-seeking (e.g., Givon 1984; Travers 2019), especially as the latter uses the same entropic measures that are applied to complexity. However, those threads of research address the pre-purchase information and choices available to a customer – which the customer may ignore at his/her option. Exported complexity, in contrast, *compels* the customer's attention and *demand*s the customer's action, before, during, and/or after the purchase.

6. Counter-trending

Several cases suggest that not all marketers will continue to export complexity over the long run.

Norwegian Airlines boards elite customers first. Remaining customers are then boarded by row. This system ‘is a proven time-saver’ (Whitmore 2018).

E-retailers have offered free, no-questions-asked return policies, in order to make customers feel comfortable about buying online (Premack 2018).

As mentioned, makers of packaged software and cloud software have made menus simple and intuitive, making manuals nearly obsolete. Moreover, you cannot ‘break’ the software by experimenting with the menus.

As for Internet advertising, Webb (2019) recalls that ‘The Internet thought interactivity would make people more amenable to persuasion: not true. It’s one thing to watch a video, it’s another to engage with it.’ Webb cites evidence that the uninterrupted narrative of a 30-second T.V.-type ad is unmatched for capturing consumers’ interest. To make an ad interactive is to add self-defeating complexity. Advertisers have thus backed away from ads that require viewers’ action (other than to click the ‘buy it now’ button).

7. Discussion and prospects

Market segmentation theorists could make a plausible case that imposing all this complexity on customers is profitable, in the short run. The fact remains, though, that products and services like the ones described above continue to be introduced under a banner of simplicity, and then grow to cause consumers to suffer more and more complexity.

Still other products, launched in a hurry in order to meet a perceived market window, are complex to begin with. Examples include the early Internet predating the World Wide Web, and personal computers with command-line interfaces (predating graphical user interfaces with icons and mouse). These latter types of products perfectly fit Rogers’ (1962) theory of innovation diffusion: They are first purchased by the ‘innovator’ psychographic segment, that are willing to endure complexity in return for the product’s sorely needed benefit, while product improvements (including simplifications) later speed the diffusion to more conservative customer segments. The digital television situation discussed above somewhat fits this model, as we may soon expect A.I.-plus-voice interfaces to replace the complex remote control devices and thus expand the market to more tech-averse customer segments.

On the contrary, the types of products (like credit cards and Ubers) that increase rather than decrease complexity over time, point to the need for a new diffusion theory that can explain their market acceptance.

In either case though – products of the first type or of the second type – companies seem disinclined to comprehend the complexity internally,⁶ preferring to export it to customers.⁷

Most of us are aware of, but do not yet own, the IoT refrigerator that automatically orders more milk when it ‘sees’ we are running low. (I travel frequently, and what I want least is another task added to my pre-departure list, namely, ‘instruct my fridge not to buy milk this week’.) What will happen when our smart speakers and other digital assistants start autonomously buying other stuff on our behalf? Johnson (2018) offers a snarky but absolutely on-target view of how this will push complexity into the customer’s lap:

Will Amazon and Google devices start ordering without explicit command? And if consumers object, will those companies say 'you contracted with us to do so, it's in the fine print?' Or perhaps say, here is a ten-page form you have to fill out and if we agree that it shouldn't have been ordered, we'll refund your money – to your Amazon or Google account, not to you – in four to six weeks.

7.1. Implications for theory

Ward (2018) traces the semantic shift of 'negative feedback' from its original cybernetic meaning of a desirable governing mechanism, to today's e-commerce meaning of 'a bad review'. Far from damping a runaway machine, the World Wide Web's constant demands for ratings and reviews place an increasing drain on customers' attention. Choosing a restaurant imposes still more complexity, as the prospective diner must, almost blindly, try to discount fake, paid, and other illegitimately motivated reviews of the eateries.⁸ Trust in received information is a key to reducing complexity, and this deserves continued research treatment.

Research should further relate complexity externalisation to the marketing literature of variety-seeking and information overload. Economists would do well to extend the theory of externalities to encompass externalisation of complexity.

The present research implies new ways of market segmentation, by attention capacity, distinguishing, e.g., hobbyists and DIYers who enjoy complexity in a certain domain, people with little or lots of attention to spare, and Rogersian 'innovators' (Rogers 1962) whose need for the product's benefit is so great as to make its complexity unimportant.

A new diffusion theory is needed to account for the non-Rogers products that increase their complexity over time. This article has cited credit cards and ride-sharing apps as examples of products with 'non-Rogers' characteristics.

'Big data' may reveal to Vendor A how much of Customer X's attention is being monopolised by Vendor B, and therefore how much of that attention remains as possible prey for Vendor A.

7.2. Implications for management practice

Third-party businesses have popped up, to advise which credit card to use for which vendor or deal, and to track your airline miles and awards. These businesses are to be applauded for providing a needed service, yet it seems that these services should *not* be needed. The original vendors (banks and airlines) could have internalised the complexity rather than foisting it on consumers. Alternatively, they could have spun off their own middleman companies to provide the service.

To be sure, many television aficionados welcome the control and the offerings afforded by digital T.V. IKEA has turned assemble-it-yourself furniture into something of a cultural meme, and numerous people are fine with it. I have observed that residents of Beijing feel empowered by being able to perform every daily function from their smartphones, notwithstanding that unlocking a public bicycle with a phone app is far more time-consuming and failure-prone than the simple card system used in other countries' bike systems. Some customer segments – particularly,

Table 1. Is a vendor externalising complexity?

	✓	Vendor side ✓	✓	✓	Customer side ✓	✓
Number of agents	Fewer	Same	More	Fewer	Same	More
Agent-agent interactions	Fewer	Same	More	Fewer	Same	More
Agent-environment interactions	Fewer	Same	More	Fewer	Same	More
Agents' adaptive behaviour changes	Fewer	Same	More	Fewer	Same	More
Changes in total vendor-customer system behaviour	Fewer	Same	More	Fewer	Same	More

hobbyists – will be more open to sharing their attention with a vendor's requirements. Others will not: Many buyers of consumer electronics, for example, absolutely will not open a manual.⁹ Moreover, this sentiment varies across national cultures.

Advertisers have always strived to capture audiences' attention, as a precursor to capturing their money. Much of the 'attention economy' literature (see, e.g., Davenport & Beck, 2001; Ciampaglia, Flammini, & Menczer, 2015) focuses on how many commercial messages a consumer can assimilate in a day. It should be clear that this article addresses attention capacity in the consumer's *action* experience, not just in their *viewing* experience.

Panko (2019) reports that customers find long 'hold' times to be the most frustrating aspect of calling a company. Holding the phone is an attention drain. The customer must stay alert for the customer service agent's pickup or callback. And this is definitely a matter of attention: Customers wait to call the service line until a moment when the opportunity cost of their time is low, so this cannot be dismissed by saying 'time is money'.

Marketers who pride themselves on giving customers 'choices' must distinguish between the pre-purchase *choices* afforded by product variety and product information, and the post-purchase complexity that *forces* the customer's attention toward one detail or another. They must distinguish between pre-purchase information that the customer is free to ignore; pre-purchase information that the vendor compels them to attend to, as in the examples of the computer vendor and the shipping company, above; and pre-purchase choices that, unknown to customers, will make their post-purchase lives more complex.

Further, marketers must not intentionally cloud the differences among these three kinds of options. (This remark is spurred by a Mitsubishi UFJ Financial Group ad¹⁰: 'Consumers ... want options, tailor-made experiences and variety. ... if a consumer chooses to allow their data to be shared with other organisations it opens a whole array of options for them, including more personalized ...', etc., etc. Also, a February 20, 2019 *China Daily* article touting a new way of boarding intercity trains using a smartphone. 'All I'll need is my phone?' enthuses one rider, while in a following paragraph the rail company admits the motive is increased internal efficiencies. Having used similar services in China, this author can attest the convenience is achieved only when the phone is well charged, when the Internet connection is strong, and when rush hour has not overwhelmed the vendor's server.)

How can a vendor know whether a new policy or action creates, reduces, or exports complexity? With the elements of the Santa Fé Institute's definition of complexity in the left-hand column, Table 1 provides a rough instrument for answering that question.

How to use the table to inform a vendor's management decisions? If the policy or action results in:

... *more net complexity on vendor side and even more on customer side*: You are externalising complexity. Examples include the P.C. sales and the airline boarding instances mentioned above. It calls for cost-benefit analysis. Is the cost, risk, and complexity of hiring, housing, equipping, and managing more P.C. sales staff more than offset by increased revenue from upselling? And is it worthwhile, considering that salespersons on commission pressure and annoy customers?

... *less complexity on vendor side and more on customer side*: You are externalising complexity. Examples include the no-signature credit card charges that cause customers more paperwork, and anxiety regarding fraudulent charges.

... *same (unchanged) complexity on vendor side and more on customer side*: You are externalising complexity. The package-shipping example illustrates. The vendor maintains the same number of desk clerks, only needing to train them to upsell. The burden of time and attention falls on the customer.

... *more complexity on vendor side, unchanged on customer side*: Beware of growing internal complexity, as warned by Perrow (1986) and Linstone and Phillips (2013).

... *unchanged complexity on vendor side and less complexity on customer side*: An example is no-fault returns of items bought via e-commerce. Gains customers, but costly for vendors.

... *unchanged complexity on vendor side and unchanged on customer side*: No problem.

... *less complexity on vendor side and unchanged on customer side*: This is classic efficiency improvement, which assumes no impact on customers except for possibly lower prices.

Further empirical research will sharpen Table 1's diagnostic instrument. Further research should also address the 'passing-through' to the customer of complexity imposed on the vendor, e.g., by new and more complicated government regulations.

On the Wednesday after Black Friday 2018 1.5 million packages were returned (Premack 2018). Premack asks, 'At what point [will] free returns become such an economic burden that merchants are forced to begin charging?' Extreme simplicity may have limits, just as excess complexity does. In today's attention economy (Davenport & Beck, 2001), the complexity/simplicity question needs more recognition and attention, in externality theory, in innovation diffusion theory, and in marketing theory and practice.

Stacey (2010) writes of 'the need to rethink management', as complex 'intra-organizational environment[s] emerge unpredictably, rather than as a result of any overall [managerial] plan'. Rather than take on this daunting task, many managers find it easier to push complexity to their customers, a tactic that can succeed only for so long.

Notes

1. <https://www.santafe.edu/about>. "the frontiers of complex systems science."
2. High-Definition Multimedia Interface

3. This offers a natural experiment: Will reduced T.S.A. headcount result in air-related terrorist incidents? At the time of writing, P.R. flacks for the unions are saying, 'Yes, risk is higher,' and government flacks are saying, 'No, it isn't.'
4. More recently, Mark Gurman and Matthew Townsend report in *Bloomberg* (May 13, 2019) that Apple stores 'began moving sales and service onto the web – encouraging staff to tell customers to "get in line, online." Customers were to make an appointment on Apple's website and then pick up the product at a store. Apple was "trying to streamline things," says one employee, "but in the process made things more difficult for some customers."
5. An example of gaming the system is the 'phantom destination hack' that flyers use to resist the airlines' complex inter-city fare structures (*The Economist*, 2015). The airlines are now fighting back, blackballing phantom destination flyers. This increases system complexity and further degrades the airlines' reputations.
6. This could be viewed as a failure of the much-touted, big-data-based 'target marketing', which strives to know what the customer wants, without asking the customer.
7. Innovative companies 'disrupting' existing industries naturally impose complex headaches on incumbent firms, and in the cases of Uber, AirBnB and others, on public agencies as well. That, however, is a different story. The present essay's focus is the deliberate imposition of complexity on customers. This focus also excludes accidental externalisation, for example, the Fukushima disaster that imposed complexity costs (tracking the path of ocean-borne radiation, assessing fisheries safety, etc.) on parties other than the Tokyo Electric Power Company (T.E.P.C.O.).
8. See Joanne Chen, Do Not Trust That Stranger's 5-Star Review. *New York Times*, May 25, 2019. <https://www.nytimes.com/2019/05/25/opinion/sunday/five-star-customer-reviews.html>".
9. Customers have been conditioned not to open manuals in part because of American software makers' and furniture makers' habit of outsourcing the complex task of instruction book authoring to non-English speaking countries. American buyers as often as not find the resulting books unreadable.
10. https://www.mufig.jp/english/ourbrand/featuredarticle/2018_03.html

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